How to reduce **12,000** Model Runs To **100** Model Runs

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Planning Community of Practice Conference 2006

Wayne Crull
Harris County
Flood Control District

me

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Picture of Downtown Houston

Flood of March 1992

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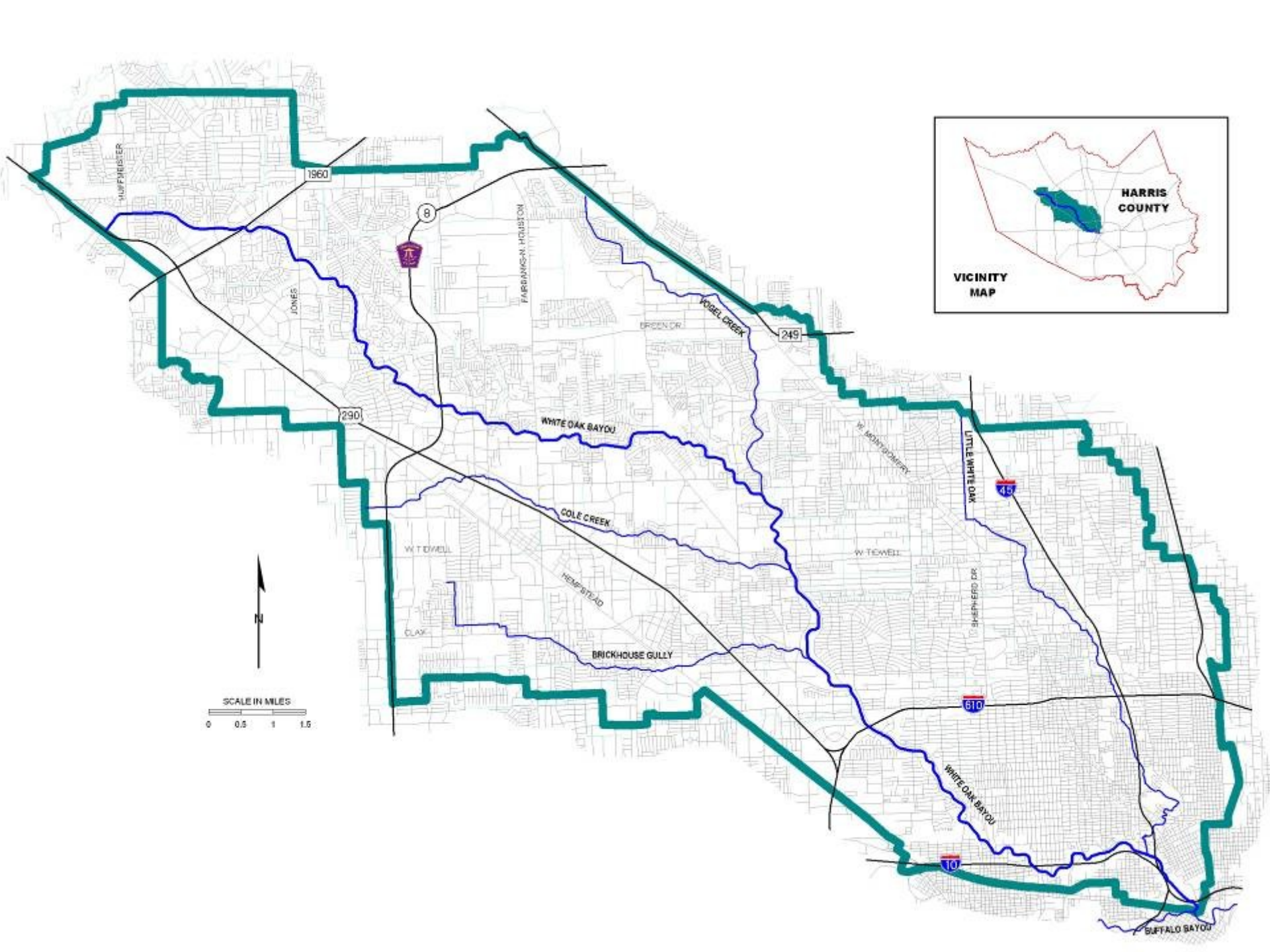
HARRIS COUNTY
VICINITY MAP
1960
8
290
249
610
10
45
WHITE OAK BAYOU
COLE CREEK
BRICKHOUSE GULLY
VOGEL CREEK
LITTLE WHITE OAK
WHITE OAK BAYOU
BUFFALO BAYOU
HUFFMEISTER
JONES
FAIRBANKS-N. HOUSTON
GREEN DR
W. MONTGOMERY
W. TIDWELL
HEMPSTEAD
CLAY
SHEPHERD DR
N
SCALE IN MILES
0 0.5 1 1.5

Flooding
Sep 1998

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CONSIDER . .

- **3 channel components**
- **5 detention basin components**
- **2 levee components**
- **2 non-structural components**

Each component considered with a minimum of 3 sizes

45 runs (minimum) required to determine the net economic benefit of each component.

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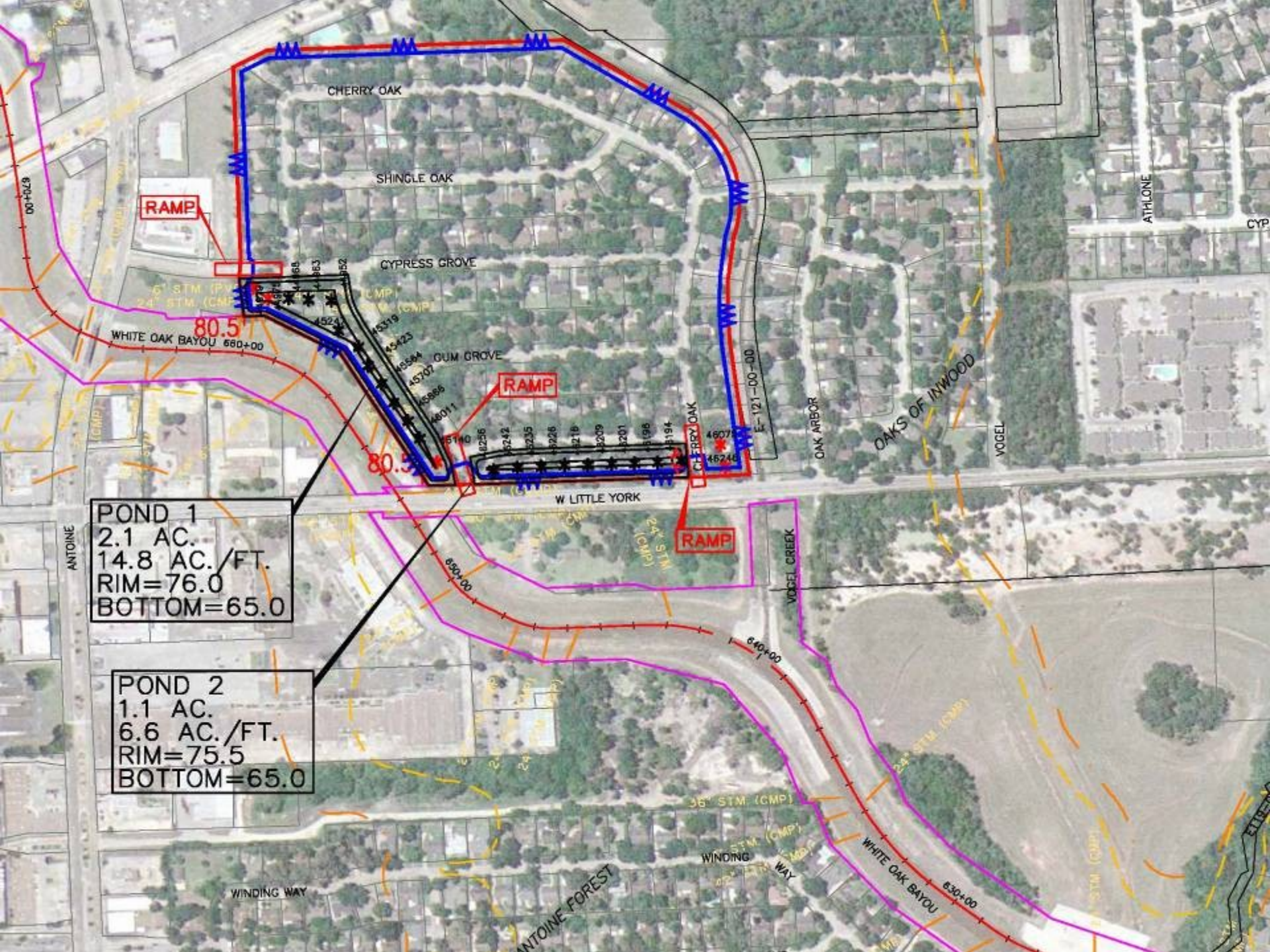
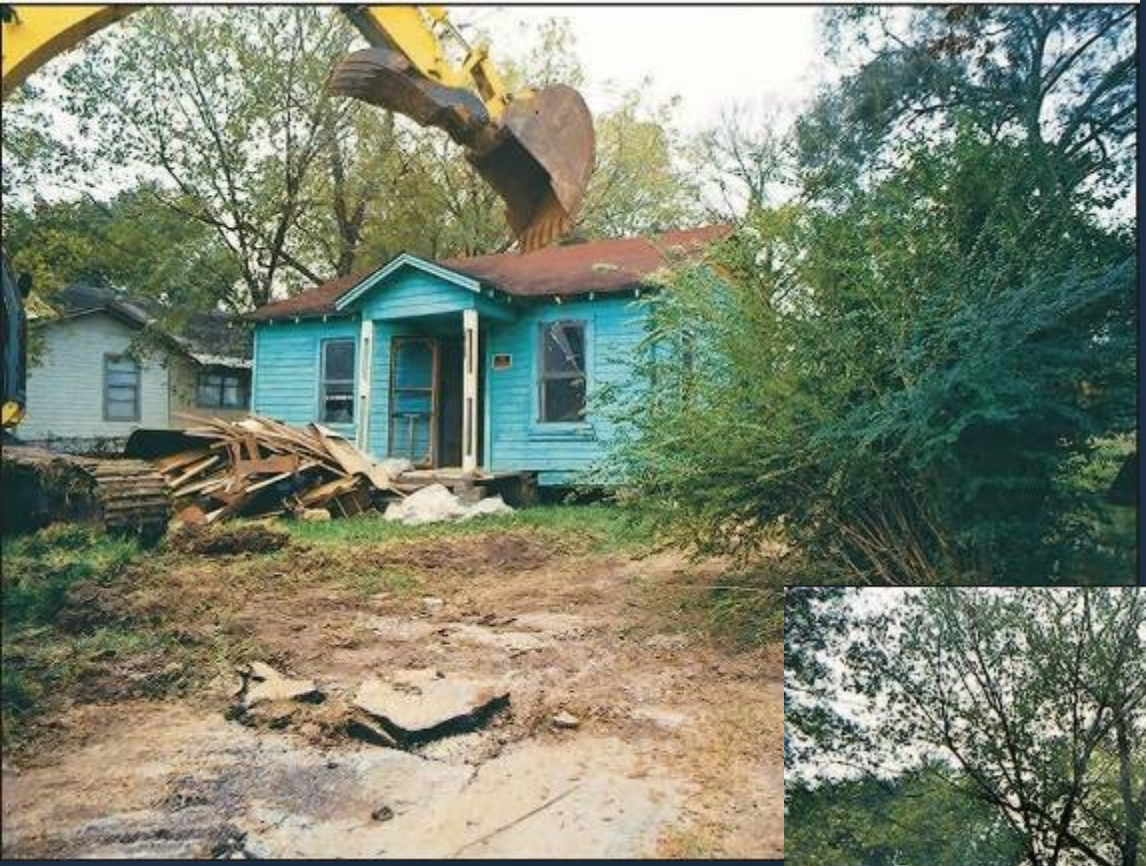

CHERRY OAK
SHINGLE OAK
CYPRESS GROVE
GUM GROVE
RAMP
RAMP
RAMP
80.5
80.5
WHITE OAK BAYOU 660+00
W LITTLE YORK
ANTOINE
VOGEL CREEK
OAK ARBOR
OAKS OF INWOOD
VOGEL
ATHLONE
E-121-00-00
690+00
640+00
630+00
WINDING WAY
WINDING WAY
WHITE OAK BAYOU
ANTOINE FOREST
24" STM. (CMP)
36" STM. (CMP)
POND 1
2.1 AC.
14.8 AC./FT.
RIM=76.0
BOTTOM=65.0
POND 2
1.1 AC.
6.6 AC./FT.
RIM=75.5
BOTTOM=65.0



CONSIDER . . .

4 ^ 8 = 65,536

runs required

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This would take

31 YEARS

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An impossible schedule

NEEDED

Strategy that fits the schedule and budget

Plan that reasonably maximizes the economic benefit

Approach that will work with a number of components that are hydraulically inter-dependent.

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Approach

1. **Screening of Measures to be considered for Components**

2. **Initial Selection**
   - **Optimize Components**
   - **Select Anchor(s)**
   - **Re-optimize Components with each Anchor as the baseline. Identify the "Optimum" size for each component**

3. **Iteration to build plan**

4. **Refinement or Last Added**

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Some definitions . . .

Re-optimize

. . . to evaluate different SIZES of unselected components to identify the best performing SIZE for each unselected component

The baseline for re-optimization will be the anchor and other previously selected components

Re-evaluate

. . . to evaluate using the previously determined best performing size of unselected components on a last added basis

The baseline for re-evaluation will be the anchor and other previously selected components

Iteration to Build Plan

1 2 3

1. Every third cycle, re-optimize the remaining unselected components
2. Re-evaluate the unselected components
3. Select the best performing component.

Repeat until there are no unselected components that provide net benefits

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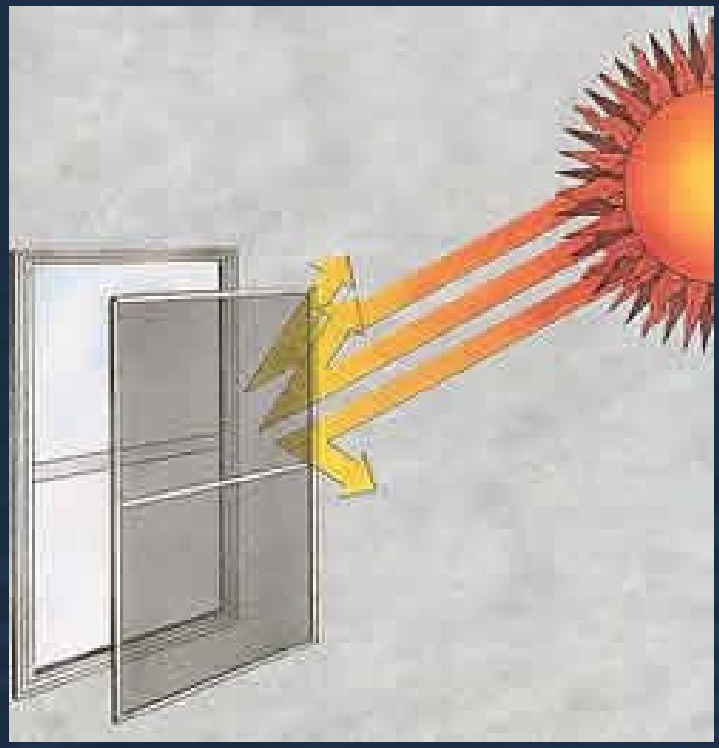
Screening

We want to SCREEN out measures that would make impractical components based on professional judgment



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Initial Selection

Components identified with letters	A, B, C, D, E etc.
Sizes of components are identified with numbers	A1, A2, A3, B1, B2, B3 etc.

Initial Selection
Optimize components

A1 = …	C1 = 5	D1 = …	G1 = …
A2 = …	**C2 =** 8	D2 = …	G2 = …
A3 = …	C3 = 2	D3 = …	G3 = …
B1 = …	F1 = …	E1 = …	H1 = …
B2 = …	F2 = …	E2 = …	H2 = …
B3 = …	F3 = …	E3 = …	H3 = …

Total number of runs = 24

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Initial Selection
Select Anchor(s)

A1 = …	C3 = 5	D1 = …	G1 = …
A2 = …	**C4 = 8**	D2 = …	G2 = …
A3 = …	C5 = 2	D3 = …	G3 = …
B1 = …	F2 = …	E1 = …	H4 = …
B2 = …	F3 = …	E2 = …	H5 = …
B3 = …	F4 = …	E3 = …	H6 = …

Initial Selection
Select Anchor(s) cont.

C4 = 8

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ANCHORS

IMPORTANT !

Know WHY each component selected or NOT selected as an anchor

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Initial Selection

Re-optimize unselected components

C4 + A1 C4 + **A2** C4 + A3		C4 + D1 C4 + D2 C4 + D3	C4 + G1 C4 + G2 C4 + G3
C4 + B1 C4 + B2 C4 + B3	C4 + F2 C4 + F3 C4 + F4	C4 + E1 C4 + E2 C4 + E3	C4 + H4 C4 + H5 C4 + H6

Total number of runs = 24 + 21 = 45

Iteration to Build Plan

Step 3 – Select best performing component

	C4 + **C3**	C4 + D2	C4 + G2
C4 + B2	C4 + F3	C4 + E4	C4 + H2

C4 + E4 has the highest value

PLAN becomes C4 + E4

Iteration to Build Plan

Step 2 – Re-evaluate unselected components

C4 + E4 + A3	C4 + E4 + H2
C4 + E4 + **B2**	C4 + E4 + F3
C4 + E4 + D2	C4 + E4 + G2

Total number of runs = 45 + 6 = 51

Iteration to Build Plan

Step 3 – Select best performing component

C4 + E4 + **A3**	C4 + E4 + H2
C4 + E4 + B2	C4 + E4 + F3
C4 + E4 + D2	C4 + E4 + G2

Total number of runs = 51

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Iteration to Build Plan

Step 2 – Re-evaluate unselected components

	C4 + E4 + **A3** + H2
C4 + E4 + **A3** + B2	C4 + E4 + **A3** + F3
C4 + E4 + **A3** + D2	C4 + E4 + **A3** + G2

Total number of runs = 51 + 5 = 56

Iteration to Build Plan

Step 3 – Select best performing component

	C4 + E4 + **A3** + H2
C4 + E4 + **A3** + B2	C4 + E4 + **A3** + F3
C4 + E4 + **A3** + D2	C4 + E4 + **A3** + G2

Total number of runs = 56

Iteration to Build Plan

Step 1 - Re-optimize the unselected components

C4 + E4 + **A3** + H2 + B3	C4 + E4 + **A3** + H2 + F2
C4 + E4 + **A3** + H2 + B4	C4 + E4 + **A3** + H2 + F3
C4 + E4 + **A3** + H2 + B5	C4 + E4 + **A3** + H2 + F4
C4 + E4 + **A3** + H2 + D2	C4 + E4 + **A3** + H2 + G1
C4 + E4 + **A3** + H2 + D3	C4 + E4 + **A3** + H2 + G2
C4 + E4 + **A3** + H2 + D4	C4 + E4 + **A3** + H2 + G3

Total number of runs = 56 + 12 = 68

Iteration to Build Plan

Step 2 – Re-evaluate unselected components

C4 + E4 + **C3** + H2 + B4	C4 + E4 + **C3** + H2 + F3
C4 + E4 + **C3** + H2 + D3	C4 + E4 + **C3** + H2 + G2

Total number of runs = 68

Iteration to Build Plan

Step 3 – Select best performing component

C4 + E4 + **A3** + H2 + B4	C4 + E4 + **A3** + H2 + F3
C4 + E4 + **A3** + H2 + D3	C4 + E4 + **A3** + H2 + G2

Total number of runs = 68

And so on
and so on
and so on

Total number of runs = 68 + 3 + 2 + 3 = 76

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Refinement

- Test each component with a larger and smaller size
- Test in the sequential order of selection (most important first)
- This effort encapsulates a formal last added process

Refinement

C3 + E4 + A**3** + H2 + D3 + B4 + F2

C4 + E4 + **A3** + H2 + D3 + B4 + F2

C5 + E4 + **A3** + H2 + D3 + B4 + F2

The Plan

Total number of runs = 76 + 2 = 78

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Refinement

And so on and so on . . .

C4 + E3 + A**3** + H2 + D3 + B4 + F2

C4 + E4 + **A3** + H2 + D3 + B4 + F2

C4 + E5 + **A3** + H2 + D3 + B4 + F2

The Plan

Total number of runs = 78 + 2 = 80

FINAL Number of runs = 80 + (2 * 5) = 90

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Compare

Exhaustive Analysis : 65,536 runs

Building a Plan

1 anchor : 90 runs

3 anchors : 270 runs

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Conclusions

An exhaustive analysis is NOT possible when there is a high number of components.

With professional judgment and experience it is possible to build a plan or set of plans which reasonably maximizes benefits by re-optimizing and re-evaluating components between steps in a selection process.

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THE END

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